



Free Flyer Concept Overview

Mike Hines

NASA/ARC Code SFD

Free Flyer Research Workshop
December 2-3, 2003

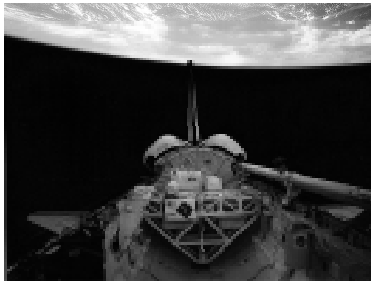
Technical Contributions
Mark Sistilli
NASA/HQ Code UM



Unique Free Flyer Capabilities



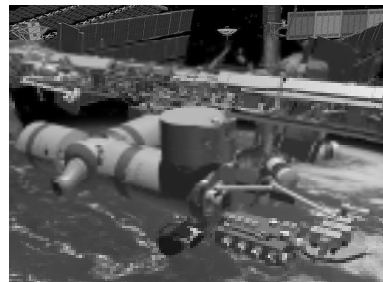
Space Shuttle



Key Capabilities

- Short Duration micro-gravity environment
- Crew operated
- Circular orbit, 28- 57° inclination at LEO
- 300 km altitude
- Return Capability

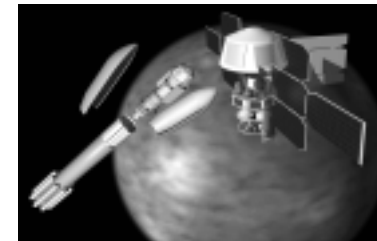
Space Station



Expanded Capabilities

- Long Duration micro-gravity environment
- Crew operated
- Circular orbit, 51 degree LEO
- Return Capability

Free Flyer



Expanded Capabilities

- Continuous sub-micro-gravity environment ($\leq 10^{-6}g$)
- Radiation environment beyond the Van Allen belts
- Use of very hazardous materials and techniques
- Robotically operated
- Expanded orbit selection
- Multiple spacecraft capability
- Flexible operations
- Return Capability (Heavy FF only)



Unique Free Flyer Capabilities

- Free Flyers are not intended to compete with or replace Shuttle and/or ISS
- Free Flyers complement capabilities available on Shuttle and/or ISS by providing the following unique capabilities:
 - **Continuous quiescence at sub-microgravity levels** to enable previously unfeasible research investigations.
 - **Use of hazardous materials, biological species, and radiation sources** that are not compatible with crewed vehicles but which are necessary to meet unique space biological and physical research objectives.
 - **Access to deep space high radiation environments** to develop risk models and test and validate candidate solutions enabling human explorations.
 - **Ability to rapidly incorporate non-human rated, evolving technologies** to maintain excellence in space research (new instruments and procedures) and to evaluate performance of new technologies for future vehicle and mission designs (spacecraft systems and operations).
 - **Flexible scheduling of launch, flight operations, and Earth return** to optimize research objectives and respond to changing research needs.



Free Flyer Study Partners



- **Science**

- ARC

- FF Overall Requirements, Study Leadership & Coordination
 - Previous Free Flyer Experience
 - Fundamental Space Biology
 - Fundamental Biology

- JSC

- Biotechnology

- MSFC

- Physical Science
 - Material Science

- JPL

- Fundamental Physics

- **Engineering**

- GSFC

- Integrated OBPR Mission Free Flyer IMDC Studies
 - System & Subsystem S/C Engineers

- JPL, LARC, ARC, MSFC, GRC

- System & Subsystem Engineers



Free Flyer Heritage



- **US Bio-Satellite (1960s)**

Mercury/Enos	1961
Biosatellite I	1966
Biosatellite II	1967
Biosatellite III	1969

- **Russian (1960s-present)**

Cosmos 110	1966
Cosmos 368	1970
Cosmos 605	1973
Cosmos 690	1974

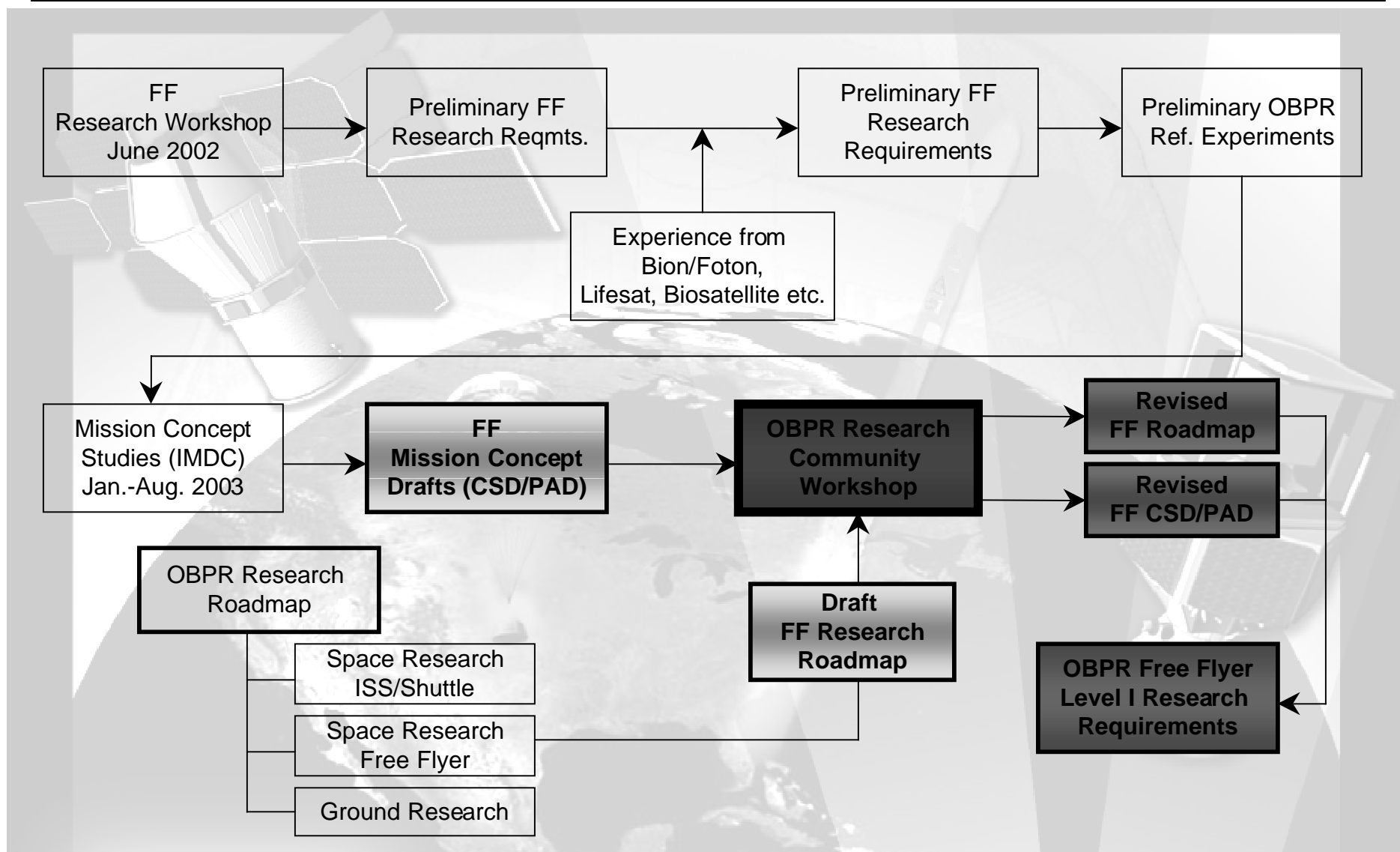
- **Joint US/Russian (1960s-present)**

Cosmos 782	1975
Cosmos 936	1977
Cosmos 1129	1979
Cosmos 1514	1983
Cosmos 1667	1985
Cosmos 1887	1987
Cosmos 2044	1989
Cosmos 2229	1993
Bion 11	1997

- **Life Sat (Study 1980s)**



Free Flyer Study Process





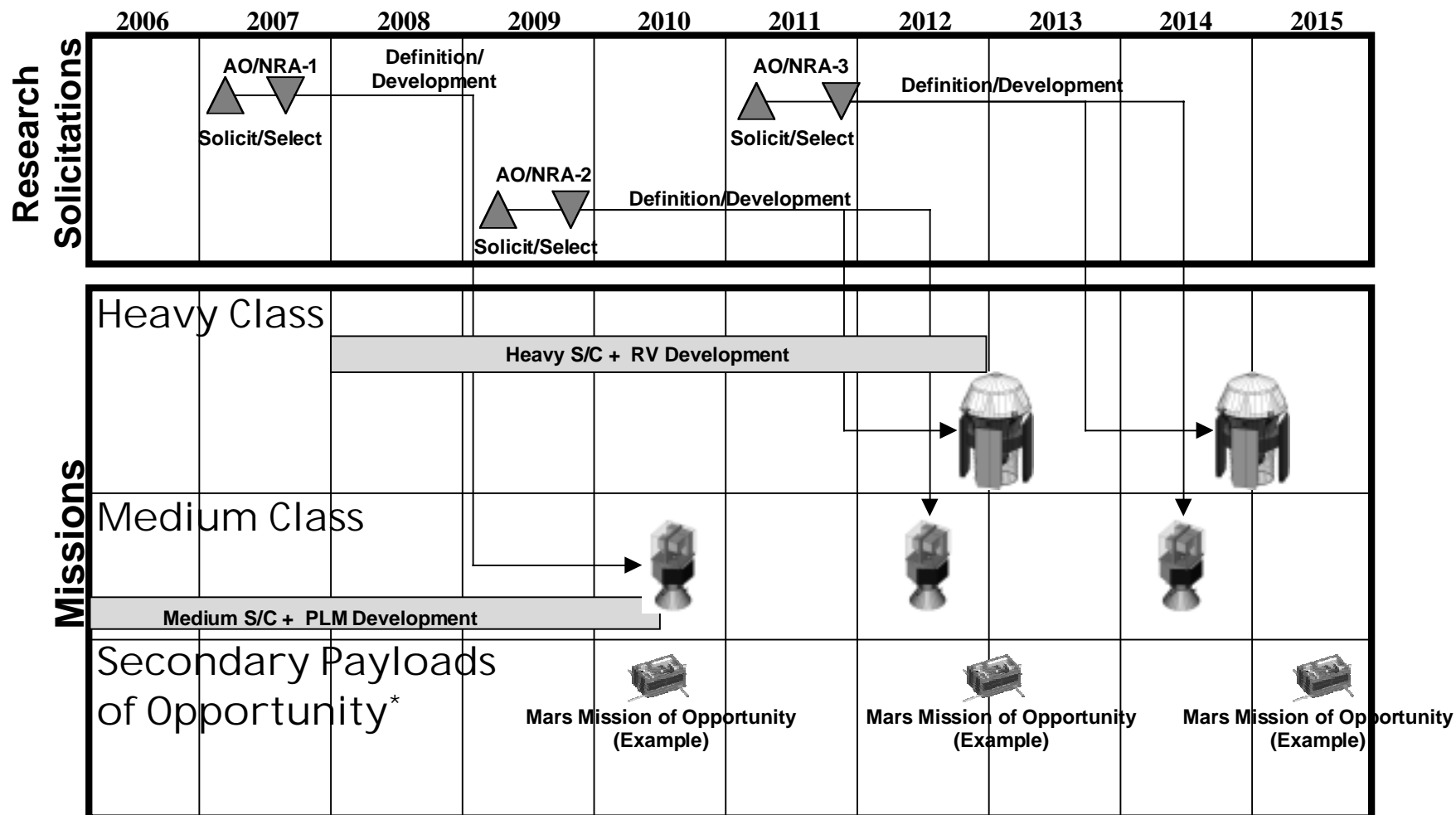
Free Flyer Study Findings



- **Preliminary study phase for Free Flyer was completed in February 2003. Study results indicated that a series of OBPR robotic spacecraft launches could:**
 - Complement and extend the baseline OBPR research utilization of the International Space Station (ISS),
 - Help mitigate the risk for future human exploration missions.
- **Initial OBPR spacecraft launches are technically possible as early as 2010, depending on programmatic considerations.**
- **This OBPR Free Flyer Workshop will seek the external OBPR research community input regarding the best research objectives and approach for such a proposed OBPR FF capability.**



FF Notional Mission Schedule



*Secondary Payloads of Opportunity will be competitively selected and will also be accommodated on OBPR and non-OBPR launchers/missions.



FF Workshop Guidance



The information presented in this workshop is a result of a good faith effort of NASA to derive a starting point for research community discussion of what a Free Flyer capability might look like.

Preliminary research objectives as defined by the NASA OBPR Enterprise disciplines, have been used as drivers for the space platform and mission concepts presented.

These are preliminary concepts only and are open for discussion and change as required to meet the combined interests of OBPR and its research community.

Our primary objective is to produce a consensus FF Research Roadmap. Our secondary objective, it to get appropriate feedback on the space platform and mission concepts in support of the OBPR FF research objectives.



Free Flyer Research Workshop Agenda



8:00 AM: **PLENARY SESSION 1**

8:00 - 8:30 Welcome, Introduction, Purpose, Objectives: OBPR NASA HQ

8:30 - 9:00 FF Concept Overview: Mike Hines, FF Study Lead, ARC

9:00 - 9:15 FF Research Roadmap Overview: Ulf Israelsson, JPL

Free Flyer Goals

15 min talk; 10 min Q & A. How Division goals relate to the FF Roadmap

9:15 - 9:40 Eugene Trinh, OBPR NASA HQ, Physical Sciences –
The Physical World (*FF Research Goal B*)

9:40 -10:05 Terri Lomax, OBPR NASA HQ , Fundamental Space Biology –
Life Interacts with the Physical World (*FF Research Goal A*)

10:05 -10:30 Frank Schowengerdt, OBPR NASA HQ, Space Product Development
Exploration Technologies (*FF Research Goal C*)

10:30 -10:45 BREAK

10:45 -11:15 Ron Leung, GSFC – *20 min talk; 10 min Q & A*
Overview of Free Flyer Capabilities and Constraints

11:15 -11:45 Ulf Israelsson, JPL - *15 min. talk; 15 min Q & A*
FF Research Roadmap
Charge to Participants

11:45–12:30 **LUNCH** (*provided on-site*)



Free Flyer Research Workshop Agenda (cont'd)



12:30 PM **SPLINTER SESSION 1 - Research Areas and Enabling Technologies**

- Free Flyer Goals A, B, C. *Update and validate Free Flyer Research Roadmap*
- A: Emily Holton, leader /Esther Hill, recorder, ARC
- B: Ulf Israelsson, leader, JPL/Brad Carpenter, HQ recorder,
- C: Louis Stodieck, leader, Univ. CO /David Boyle, recorder, Texas A & M

For each Goal – Add or subtract to 1) Research Areas, and 2) Enabling Technologies. Rank and prioritize from 1-3 (High Priority/Want/Don't Care)

5:00-6:30: Hors d'Oeuvres/Beverages

6:30-8:30: **SPLINTER SESSION 1** *(continue as needed)*

DAY TWO:

7:30-8:00 AM Coffee/Pastries

8:00 AM: **PLENARY SESSION 2**

8-8:15 Ulf Israelsson

Summary results from the 3 splinter sessions

8:15-8:45 A: Emily Holton, leader /Esther Hill, recorder

8:45-9:15 B: Ulf Israelsson, leader/Brad Carpenter, recorder

9:15-9:45: C: Louis Stodieck, leader/David Boyle, recorder

10:00-10:30 AM BREAK



Free Flyer Research Workshop Agenda (cont'd)



10:30-12:00 **SPLINTER SESSION 2 - Spacecraft Capabilities**

- Free Flyer Goals A to C (Same breakout groups as Day1)
- A: Mike Skidmore and Emily Holton, leaders; Esther Hill, recorder,
- B: Ron Leung and Ulf Israelsson, leaders; Brad Carpenter, recorder
- C: Al Lieberman and Louis Stodieck, leaders; David Boyle, recorder

For each Goal – Add to or subtract from Capabilities matrix. Be specific, so that sufficient feedback is provided to the ARC/GSFC Engineering Design group to update their current design concept.

12:00-1:00PM: **LUNCH** *(provided on-site)*

1:00 - 2:30 PM **SPLINTER SESSION 2** *(continue)*

2:30 – 3:00 BREAK

3:00: **PLENARY SESSION 3**

Ulf Israelsson Summary results from Splinter Session No. 2

3:00 - 3:20 Mike Skidmore

3:20 - 3:40 Ron Leung

3:40 - 4:00 Al Lieberman

4:00 – 4:45 WRAP-UP

- Science Representatives with DDs, Ulf Israelsson, Louis Stodieck, Emily Holton
Determine if Free Flyer Study concept and capacity is appropriate
- Mike Hines, Free Flyer Study Lead
Forward work
Thanks to all



Free Flyer Research Workshop Logistics

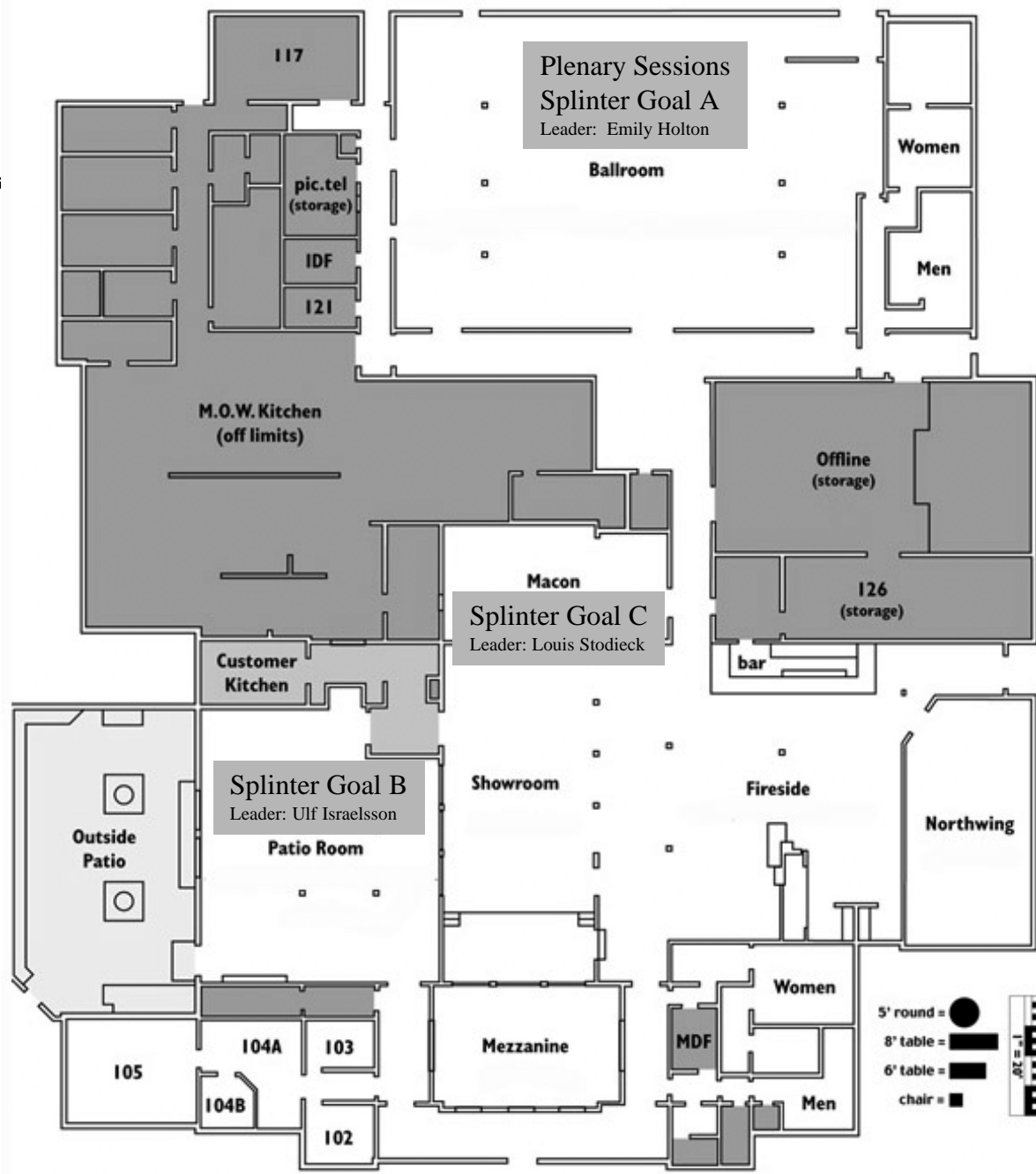


- **Overall Meeting Support (Joellen Jarvi ,POC)**
 - Registration Issues - Front Registration Desk

- **IT / Power / Presentation Support**
 - (AM-Alex Hidalgo/604-2228)
 - (PM-Robert Chong/604-0821)

- **Phones/Restrooms/Reproduction**
 - Available all around (
 - Long Distance, use pay phones near restrooms,
 - On-site & local calls on all phones
 - Note microphone locations for Q&A


- **General Logistics/Travel/Supplies (Arlene Pineo, POC)**



December 2, 2003



Free Flyer Sample Return Mission Visualization




OBPR

Heavy Spacecraft


Mission Visualization

Michael.L.Hines@NASA.gov



Ames Research Center

RogerArno@Comcast.Net



December 2, 2003